Human Heart Rate Detection Application

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Human Heart Rate Detection Application

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Abstract— **Modern daily activities make some people have difficulty to care about his health. Urban air pollution, work pressure, and irregular diet increase the risk of such a person to become infected. In fact, some of the diseases would not cause any symptoms prior to severe ones. One of them is the coronary heart disease. According to a study conducted by the WHO (World Health Organization), in 2030 an estimated 23 million lives lost each year from cardiovascular disease. This value will continue to grow if no proper solution is run.**

Internet of Things (IoT) technologic developments allow humans to control a variety of high-tech equipment in our daily lives. One of these is the ease of checking health use gadgets, either phone, tablet or laptop. In this paper described the use of IoT technology in the human heart rate measurement that can be monitored using the gadget. Result of this application, people can easily monitor their heart rate.

Keywords—IoT; gadget; heart rate; measurement

I. INTRODUCTION

Based on information taken from the site of the World Health Organization (WHO), estimated that in 2008 approximately 17.3 million people die from cardiovascular disease. 80% mortality from the disease occur in countries with low to medium incomes (low and middle-income countries). Estimated mortality rate is then calculated to obtain the data that by 2030 more than 23 million people will die each year from cardiovascular disease.[1]

In 2005, an organization in the United States that are part of the ministry of health and community services, CDC (Centers for Disease Control and Prevention), conducted a survey in 2005. 92% of respondents recognize chest pain as a symptom of a heart attack. However, only 27% were aware of all the symptoms and know how to make an emergency call when someone is having a heart attack. Approximately 47% of sudden cardiac deaths occur outside the hospital. It shows that many people with early symptoms of heart attack are not acting respond. The key to avoiding death from a heart attack just by recognizing the early symptoms of a heart attack.[2]

Based on the fact that many mobile phone users in Indonesia and problems regarding the indifference of many people about heart health, this paper presents a smartphone app that can measure heart rate to users. Applications created based operating system windows phone 8.0. Figure 1 shows block diagram of human heart rate detection system. Applications connect to additional external devices with the communication media such as Bluetooth. External devices work to record the heartbeat of the fingers in any particular period by utilizing an infrared sensor.[3] The heart rate data is then processed by a microcontroller and then sent to the smartphone in question. Application role is to infer the level of heart rate on the user.[4] January 2014 contained 112% of the Indonesian population active mobile subscription. This indicates that almost the entire population of Indonesia already has a cell phone. Users interact with smartphones through applications that have an interface GUI (Graphical User Interface). Entertainment apps, multimedia apps, productivity apps, news and weather apps

II. DESIGN

This system includes the involvement of hardware and software in the form of mobile applications. Hardware acts as the input system. That is, in this section there are sensors that can detect the environment. Meanwhile, the mobile application serves as the system output to the user. Both components are connected via the Bluetooth wireless communication.

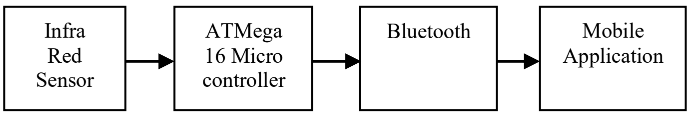

Fig 1. Block Diagram of human heart rate detection system

On the hardware side, there are three main components, namely component processors, sensors, and a Bluetooth module. Microcontroller ATMega 16 works as a processor which will execute any commands that exist in the hardware. Sensors embedded in the system is an infrared sensor that consists of an IR LED and photodiode. The sensors are useful for detecting the heartbeat of the fingers of the user. The raw data that has been received by the sensor is then processed by a microcontroller. The processed data are then sent wirelessly to mobile applications via a Bluetooth connection. Applications will process the data for later display and concluded. The application works on smartphones running Windows Phone 8.0 operating system.[5]

A. External hardware Design

The design of the system hardware detection of human heart rate based on operating system Windows Phone 8.0 using the infrared sensor includes:

1. Design minimum system microcontroller AT Mega 16

2. The design of the infrared sensor

3. The design of the Bluetooth module

This system combines hardware power supply circuit and the three sub-systems that have been mentioned earlier. Sensor and Bluetooth modules incorporated in the minimum system form a larger system as shown in Figure 2. The figure explains the schematic diagram of the hardware, but the hardware realization is printed in the form of PCB. Users simply press the switch to turn on or off the device. The setting and synchronization is done via Bluetooth windows phone. This hardware has dimensions of 11.6 cm × 9 cm × 10 cm making it possible to carry around (portable).

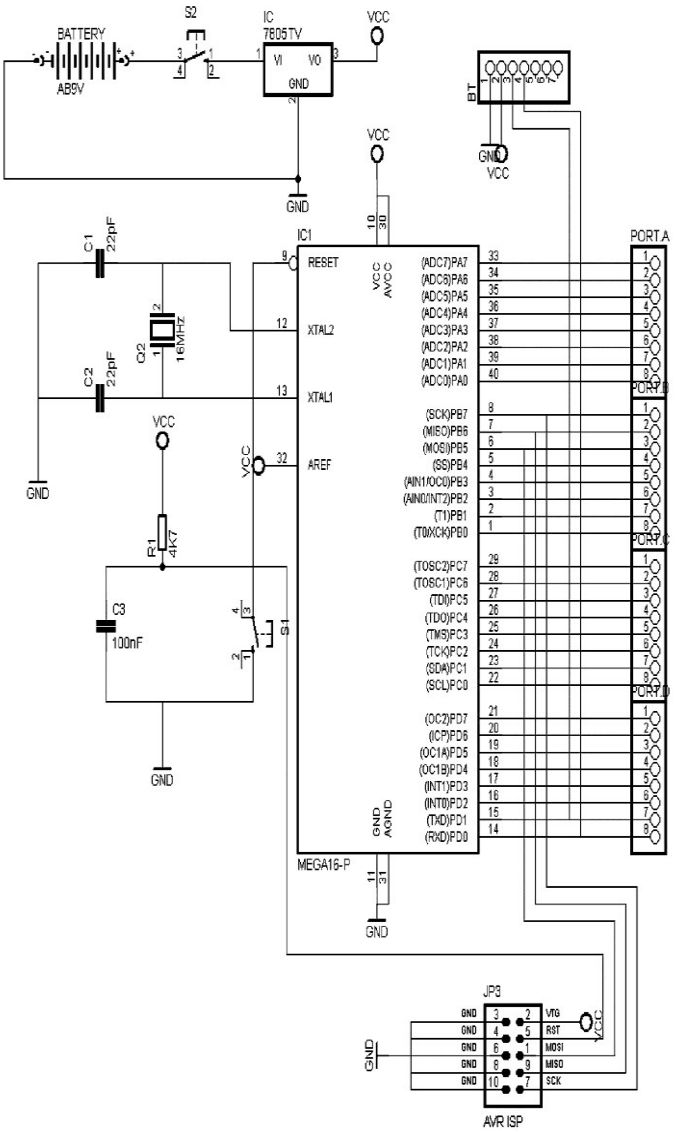

Fig 2. Schematic of hardware circuit diagrams

1. Design minimum system microcontroller AT Mega 16

The minimum system microcontroller ATmega16 is required in order to function properly. Therefore, the minimum system design is applied and become the primary circuit on additional hardware. A 16MHz crystal oscillator, two 22pF capacitors, a capacitor 10nF, a 4.7 KΩ resistor, and a push-button arranged in such a manner as shown in Figure 2. Pin VCC, AVCC and AREF is connected to the source voltage to the microcontroller is active as well as ADC features. ADC feature is enabled because it will be used by the microcontroller to process the analog data received from the sensors. GND and AGND pin is connected to ground.[6]

2. The design of the infrared sensor

Infrared sensor consists of an IR LED and photodiode are arranged side by side. Infrared LED circuit is quite simple, by connecting the anode to the cathode to VCC and ground. For 330Ω resistor is included in it to prevent the receipt of a current too large by LEDs. Another thing with photodiode circuit is a little more complicated. Walking photodiode cathode connected to VCC and feet anode with ground (photodiode reverse bias assembled using the relationship). Besides connected to VCC, foot cathode is also connected to the 40th pin (Pin A0) AT Mega microcontroller 16. This pin serves as the microcontroller ADC channel used to receive data from the sensors. In the circuit there is also a 10 KΩ resistor provides the same functions as the resistor in the circuit of the IR LEDs. The series of infrared sensors on the detection system of human heart rate can be seen in Figure 3.

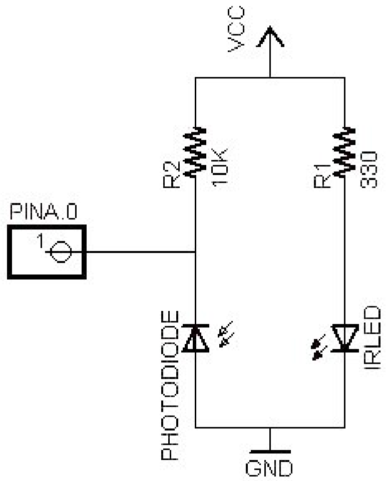

Fig 3. Infra-Red Sensor Circuit

3. The design of the Bluetooth module

Communication between hardware with mobile applications is done wirelessly (wireless) using Bluetooth technology. Bluetooth module used in this system is the type DFRobot V3. There are 7 feet owned by the Bluetooth module. However, only 4 feet used by the system. The legs are VCC, GND, TX and RX. Walking VCC and GND connected to the voltage source to activate the Bluetooth module. While Walking TX connected to pin 14 (RXD) and RX leg connected to the pin 15 (TXD) microcontroller. Both pin is responsible for delivering the data to be sent or received by the microcontroller via Bluetooth module. Bluetooth module circuit is shown in Figure 4.

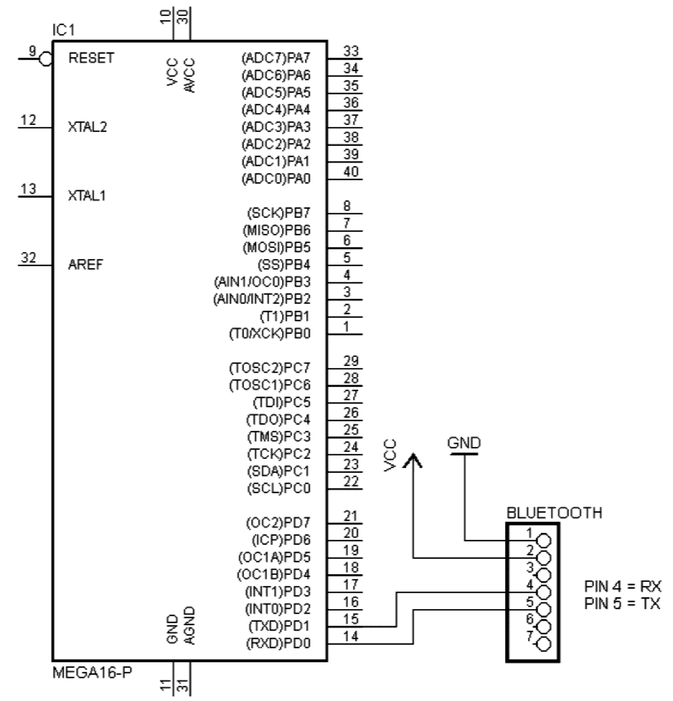

Fig 4. Bluetooth Module Circuit

There are several similar researches like paper of Bandana Mallick and Ajit Kumar Patro, Heart Rate Monitoring System Using Finger Tip Through Arduino Uno And Processing Software.[7] Jongyoon Choi and Ricardo Guiterrez-Ozune's paper, Using Heart Rate Monitors to Detect Mental Stress.[8]

Flow hardware program begins with the initialization Analog-to-Digital Converter (ADC). Initialization is intended to enable ADC features provided by CodeVision AVR. In addition to ADC, other features were used that USART. Therefore, the initialization process is also made to the USART. In this stage, both USART transmitter and receiver are enabled. Because the hardware is sending and receiving data from the application. The next stage is to initialize the port A as an input. Port A is set as an input for a sensor mounted on the port A. The sensors will provide data input to the microcontroller. A port initialization as the input is done via the command DDRA = 0x00. Port rest act as output because they will provide the data output of the microcontroller. For example, data to be sent by the Bluetooth module. The command to initialize the port as output is DDRi = 0xFF (i = Name of the port).

There are several variables that were made in the program's hardware. Variables with names initVal, finalVal, and range, has an integer data type (int). While other variables with names transmitChar have a character data type (char). These variables will be used to store a certain value. FinalVal variable has an initial value of 0 (zero), while the other variables are set to have an initial value. Then, the program flow followed by reading from the sensor port A pin-0. The data obtained from the sensor is analog data, so it needs to be converted by the ADC into digital data that can be processed. Then, save the digital value in the variable initVal. A formula is used to process the finalVal and initVal value, the formula is:

$$range = [finalVal - initVal] \quad (1)$$

This Formula has a function of the difference between the absolute value finalVal initVal. The result of the calculation was then set as the variable value range. If the value range ranged between 3-7 then invoke subroutines SendData. If the requirements are not met, then proceed to the next command line. Commands from the sensor readings to call subroutines are in the loop forever. Accordingly, all such orders will continue to be repeated. Description of program flow is summarized in the flow diagram in Figure 5.[9]

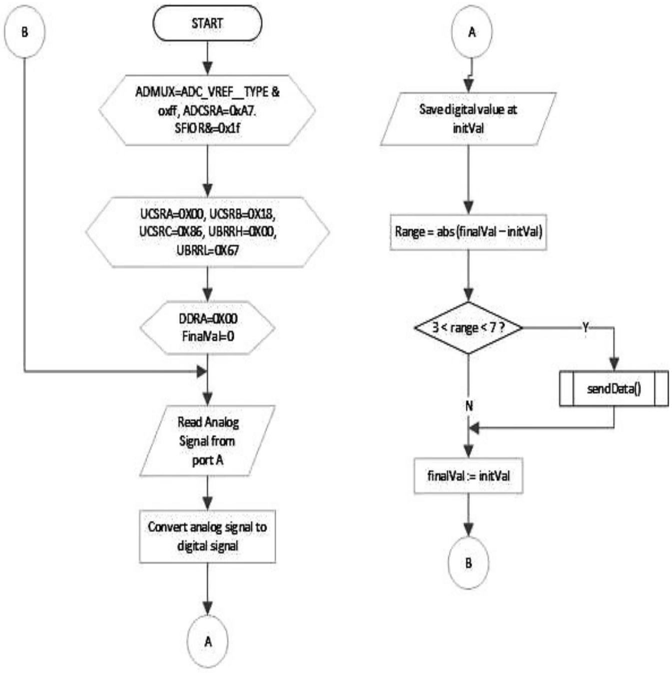

Fig 5. System Flowchart

B. *Mobile Application Design*

Software design detection system human heart rate based on operating system Windows Phone 8.0 using the infrared sensor is divided into two parts. The first part is a program to run additional hardware. The second part is a mobile application that operates on a Windows phone. The program planted on a microcontroller fabricated using C language programming software used is CodeVision AVR. Another thing with mobile applications built using XAML and C #. XAML language is used to declare an application's user interface. Meanwhile, C # is used as the code-behind. Programming software is used to build their mobile applications is visual studio express for windows phone.

The program on the microcontroller intended for reading by the sensor and sending data via bluetooth. Mobile application consists of 2 pages which display the input (input) of user data and page output (output). Weather data entry page called "MainPage.xaml". This page is tasked to retrieve the data for age, sex, and activity. Although, there are two columns ie first name and last name are aiming for further development towards a database. The output page called "HeartbeatPivot.xaml" which allows you to display data from the application process. Data shown are gender, age, activity, heart rate, maximum heart rate (maximum heart rate), and its conclusions heartbeat condition. There is a timer (timer) which indirectly instruct users to keep putting the finger on the sensor during run time. This application has several methods that are declared and called on both pages. In the manufacturing process, these applications directly simulated in the windows phone operating system Windows Phone 8.0.

C. *Mainpage Interface*

Mainpage page has textblock 3 pieces, 4 pieces Radiobutton, an application bar button, and some TextBlock as shown in Figure 6. Elements of this interface serves as a user enters data. Column first name and last name will not affect the processing of the data by the application. The second column is intended for further development of the application Heartbeat.

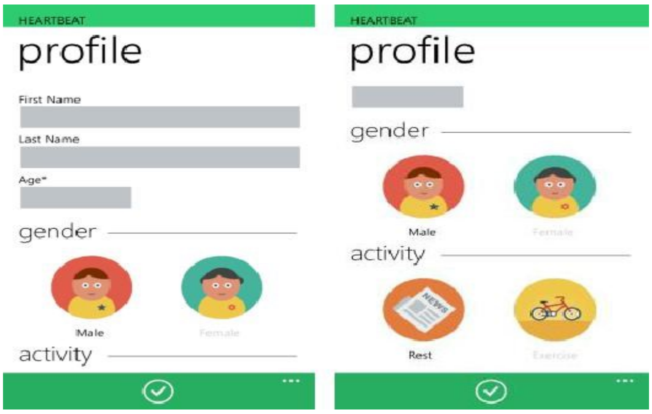

Fig 6. Main page Interface

Users must enter data for age, sex, and activity that is being conducted via this page. For the age data, user input by touching the age column. Then the on-screen keyboard will appear and the user can type a number of age. As for the data gender and activity, users simply touch one choice of several options available. Male gender selection is symbolized by the image of a male and female sexes is symbolized by the image of a woman. In the activity, choice of activity breaks symbolized by the image of newspapers and strenuous activity symbolized by pictures bike.

D. *Heart rate Detection System*

Figure 7 shows flowchart of main page and A schematic diagram of the entire system is shown in Figure 8. The system is divided into two parts, namely hardware and mobile applications. The hardware includes a microcontroller, sensors, power supply, Bluetooth modules, and other electronic components are incorporated in an electrical circuit. The hardware will transmit heart rate data on the application to be processed. The mobile application will calculate the number of beeps and concluded normality of the heart rate of the user.

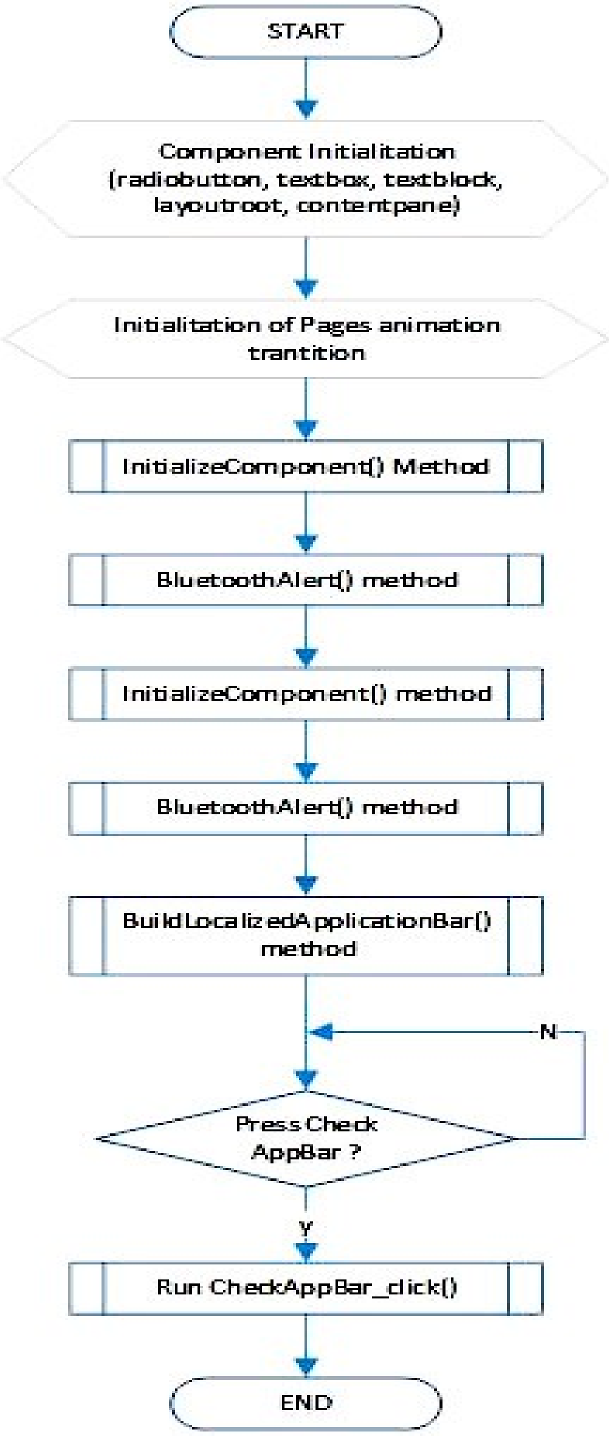

Fig 7. Main page Flowchart

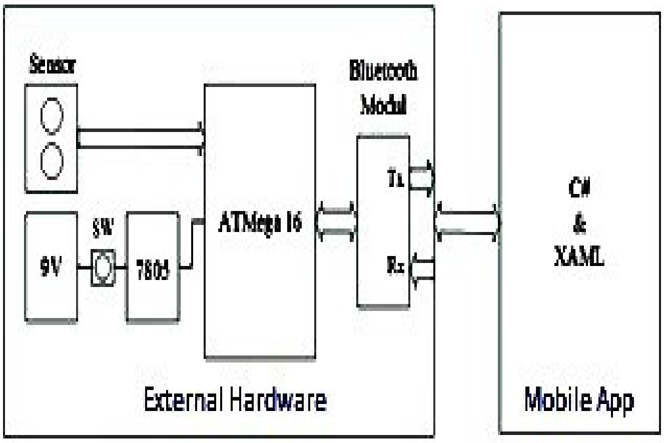

Fig 8. Heart rate Detection System

The device is composed of a variety of electronic components and integrated circuits incorporated in a PCB (Printed Circuit Board). PCB is packaged in a beam dimensions of 11.6 cm × 9 cm × 10 cm. The beam has two compartments: the battery space and PCB space. Hardware is powered by a 9V battery that is located on the bottom of the beam. A power button (power button) located on the upper side, while the sensor is in the front left side. Sensors placed in a cavity to minimize interference due to ambient light system. Looks beyond the hardware shown in Figure 9.

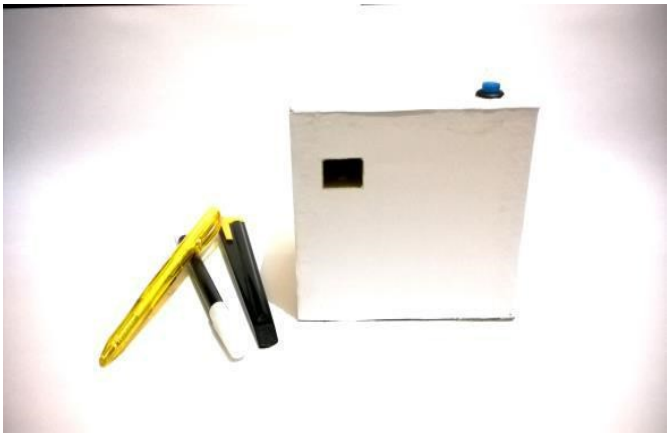

Fig 9. External Hardware

Users should turn on additional hardware by pressing the blue button before the application is run. Then to start the recording process, place your index finger on the sensor. Then, Bluetooth will send data to the application to be processed. All activities are governed by the microcontroller ATMega 16 embedded in the PCB measuring 12.5 cm × 7.5 cm. Physical appearance PCB is shown in Figure 10. The sensor has its own PCB (separate from the main PCB). This is because the sensor must be conditioned clamp user's finger. Thus, created two others on the system PCB is PCB IR LED and photodiode. PCB IR LEDs are placed at the bottom of the cavity (LED attached to the fingers) and photodiode PCB. There is on the finger (photodiode attached to the nail).

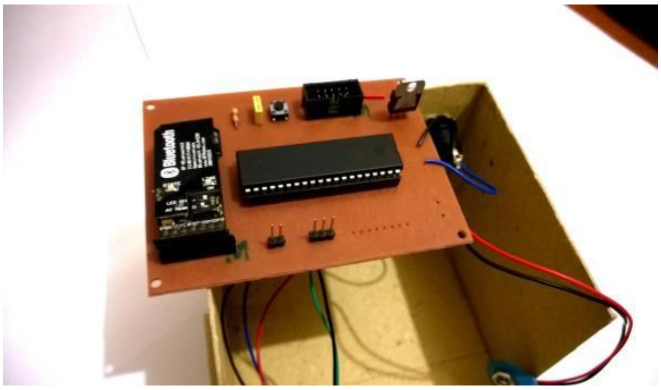

Fig 10. Main PCB

III. TESTING

Table I. Users identity

Input Data			Output Data						
Age	Sex	Activity	HR	Max HR	Age	Sex	Activity	Status Bar	Animation
20	Man	Rest	x	200	20	Male	Rest	Device is ready	x
35	Man	Exercise	x	200	35	Male	Exercise	Device is ready	x
20	Woman	Rest	x	189	20	Female	Rest	Device is ready	x
35	Woman	Exercise	x	189	35	Female	Exercise	Device is ready	x

*HR = Heart Rate

Table II. Users tests

Input Data			Output Data						
Age	Sex	Activity	HR	Max HR	Age	Sex	Activity	Status Bar	Animation
20	Man	Rest	x	200	20	Male	Rest	Recording Your Heartbeat	MyAnimatedEllipse, MyAnimatedLittleEllipse, txbRateOut
35	Man	Exercise	x	200	35	Male	Exercise	Recording Your Heartbeat	MyAnimatedEllipse, MyAnimatedLittleEllipse, txbRateOut
20	Woman	Rest	x	189	20	Female	Rest	Recording Your Heartbeat	MyAnimatedEllipse, MyAnimatedLittleEllipse, txbRateOut
35	Woman	Exercise	x	189	35	Female	Exercise	Recording Your Heartbeat	MyAnimatedEllipse, MyAnimatedLittleEllipse, txbRateOut

Table III. Calibration Test

Testing	Real Heart rate	App Heart rate	Different	Real Status	App Status	Conclusion	
						HR	Result
1	80	72	-8	Normal	Normal	False	True
2	72	69	-3	Normal	Normal	False	True
3	72	61	-11	Normal	Normal	False	True
4	76	80	+4	Normal	Normal	False	True
5	72	87	+15	Normal	Normal	False	True
6	80	94	+14	Normal	Normal	False	True
7	72	87	+15	Normal	Normal	False	True
8	76	65	-11	Normal	Normal	False	True
9	76	47	-29	Normal	Low	False	False
10	76	69	-7	Normal	Normal	False	True
11	72	83	+11	Normal	Normal	False	True
12	76	120	+44	Normal	High	False	False
13	84	98	+14	Normal	Normal	False	True
14	76	98	+22	Normal	Normal	False	True
15	76	87	+11	Normal	Normal	False	True
16	72	61	-11	Normal	Normal	False	True
17	72	91	+19	Normal	Normal	False	True
18	84	120	+36	Normal	High	False	False
19	76	50	-26	Normal	Low	False	False
20	72	72	0	Normal	Normal	True	True
21	76	69	-7	Normal	Normal	False	True
22	76	58	-18	Normal	Normal	False	True
23	76	65	-11	Normal	Normal	False	True
24	72	61	-11	Normal	Normal	False	True
25	72	65	-7	Normal	Normal	False	True
26	84	83	-1	Normal	Normal	False	True
27	72	80	-8	Normal	Normal	False	True
28	72	69	-3	Normal	Normal	False	True
29	72	72	0	Normal	Normal	True	True
30	76	83	7	Normal	Normal	False	True

Testing condition:

1. The value of the calibration used is 0.91. This value is used to minimize the difference between pulse applications with normal pulse.

2. Percentage Error:

   ∑different = 384

   $$\text{Different Average} = \frac{\sum \text{different}}{30} = 12.8$$

   $$\text{Error} = \frac{4}{30} \times 100\% = 13.33\ \%$$

3. Pulse and decisions fact is measured by calculating the heart rate manually by pressing a finger on the body that feels the pulse.

IV. CONCLUSION

1. Application detection of human heart rate based on operating system Windows Phone 8.0 using the infrared sensor successfully realized. Applications built using the language XAML and C # with Visual Studio Express for Windows Phone.

2. Additional hardware successfully realized in the form of Printed Circuit Board (PCB) and packaged in blocks. The hardware is programmed using C language to program AVR CodeVision. No problems were found that the percentage of errors on certain aspects. The error is most likely caused by a mismatch of sensors. However, this can be minimized by providing calibration value.

3. Additional hardware with mobile applications can be connected with a Bluetooth connection. The hardware is able to send data, and the application is able to receive data from the hardware properly.

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ICSIIT 2017 - Notification Paper 14

7 messages

Conference Management Toolkit <email@msr-cmt.org> Fri, Apr 7, 2017 at 3:28 PM
Reply-To: Leo Willyanto Santoso <leow@petra.ac.id>
To: Semuil Tjiharjadi <semuiltj@gmail.com>

Dear Semuil Tjiharjadi,

Thank you for your submission to The 5th International Conference on Soft Computing, Intelligent System and Information Technology.

Following review by the Program Committee, I am pleased to inform you that your submission entitled "Human Heart Rate Detection Application" has been accepted for presentation at the conference - congratulations.

You will find comments from the reviewers by logging in to your CMT account. Please take these comments into account when preparing the final camera ready version of your paper. You must submit your final paper before April 21, 2017.

Presenting authors are required to register and pay fees by April 28, 2017. At that time, your paper publication will be cancelled if you are not yet registered with fees paid in full.

Again, congratulations on your acceptance. We look forward to meeting you in Denpasar Indonesia.

Yours sincerely,

Leo Willyanto Santoso

Semuil Tjiharjadi <semuiltj@gmail.com> Sun, Apr 23, 2017 at 7:36 PM
To: Leo Willyanto Santoso <leow@petra.ac.id>

Dear Leo Willyanto Santoso,

We have submitted camera ready paper at April 20, 2017.
The question from my institution is when we have to pay fees?
April 28, 2017 or **16 June 17 (Information from http://icsiit.petra.ac.id/ about:** Deadline of Early Bird Registration Payment and Camera Ready Paper)

Thank sincerely,

Semuil Tjiharjadi

[Quoted text hidden]

Leo Willyanto <leow@petra.ac.id> Tue, Apr 25, 2017 at 12:49 PM
To: Semuil Tjiharjadi <semuiltj@gmail.com>

Dear Pak Semuil,

Warm regard from Petra Christian University.
Thank a lot for your participation in this conference.
The deadline of early bird registration payment is April 28, 2017.
June 16, 2017 is for the 2nd batch. We have 2nd batch, now is still running.
Thank you.

Best regards,
Leo W. Santoso

[Quoted text hidden]

Semuil Tjiharjadi <semuiltj@gmail.com> Mon, May 1, 2017 at 8:56 PM
To: Leo Willyanto <leow@petra.ac.id>

Dear Mr Leo,

I sent you proof of early bird payment of my paper in ICSIIT 2017 via PermataBank.
Please give confirmation about my status payment. Thank you
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To: Semuil Tjiharjadi <semuiltj@gmail.com>

Dear Mr. Semuil,

I'll give the confirmation of payment tomorrow.
Thanks.

Regards,
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Leo Willyanto <leow@petra.ac.id> Thu, May 4, 2017 at 10:46 AM
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Dear Pak Semuil,

Sorry for the late response. We have received your payment.
Sampai jumpa di Bali.

Regards,
Leo W. Santoso
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Semuil Tjiharjadi <semuiltj@gmail.com> Thu, May 4, 2017 at 10:18 PM
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Thanks for confirmation.

Semuil
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Reviewer #1

Review Questions

1. Technical quality (depth and/or breadth of coverage)

- Fair

2. Presentation (clarity and readability)

- Fair

3. Novelty (originality of the idea)

- Fair

4. Importance / relevance (to ICSIIT)

- Good

5. Comments

- All the references should be cited, all the figures and tables should be mentioned in the text and give same explanation. Kindly use high-resolution images in the figures. Also, change all texts in the figures to English. The results have to be explained in the abstract. No previous research mentioned in this paper. Some text of the template still appear in the text. Add some others research concerning this topic.
- Semua referensi harus dikutip, semua gambar dan tabel harus disebutkan dalam teks dan memberikan penjelasan yang sama. Mohon gunakan gambar beresolusi tinggi pada gambar. Juga, ubah semua teks dalam gambar ke bahasa Inggris. Hasilnya harus dijelaskan secara abstrak. Tidak ada penelitian sebelumnya yang disebutkan dalam makalah ini. Beberapa teks template masih muncul dalam teks. Tambahkan beberapa penelitian lain mengenai topik ini.

6. Overall recommendation

- Neutral

Human Heart Rate Detection Application

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Keywords—IoT; gadget; heart rate; measurement

I. INTRODUCTION

Based on information taken from the site of the World Health Organization (WHO), estimated that in 2008 approximately 17.3 million people die from cardiovascular disease. 80% mortality from the disease occur in countries with low to medium incomes (low and middle-income countries). Estimated mortality rate is then calculated to obtain the data that by 2030 more than 23 million people will die each year from cardiovascular disease.

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This system includes the involvement of hardware and software in the form of mobile applications. Hardware acts as the input system. That is, in this section there are sensors that can detect the environment. Meanwhile, the mobile application serves as the system output to the user. Both components are connected via the Bluetooth wireless communication.

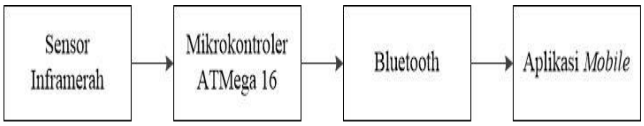

Fig 1. Block Diagram of human heart rate detection system

On the hardware side, there are three main components, namely component processors, sensors, and a Bluetooth module. Microcontroller ATMega 16 works as a processor which will execute any commands that exist in the hardware. Sensors embedded in the system is an infrared sensor that consists of an IR LED and photodiode. The sensors are useful for detecting the heartbeat of the fingers of the user. The raw data that has been received by the sensor is then processed by a microcontroller. The processed data are then sent wirelessly to mobile applications via a Bluetooth connection. Applications will process the data for later display and concluded. The application works on smartphones running Windows Phone 8.0 operating system.

A. External hardware Design

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The design of the system hardware detection of human heart rate based on operating system Windows Phone 8.0 using the infrared sensor includes:

1. Design minimum system microcontroller AT Mega 16

2. The design of the infrared sensor

3. The design of the Bluetooth module

This system combines hardware power supply circuit and the three sub-systems that have been mentioned earlier. Sensor and Bluetooth modules incorporated in the minimum system form a larger system as shown in Figure 2. The figure explains the schematic diagram of the hardware, but the hardware realization is printed in the form of PCB. Users simply press the switch to turn on or off the device. The setting and synchronization is done via Bluetooth windows phone. This hardware has dimensions of 11.6 cm × 9 cm × 10 cm making it possible to carry around (portable).

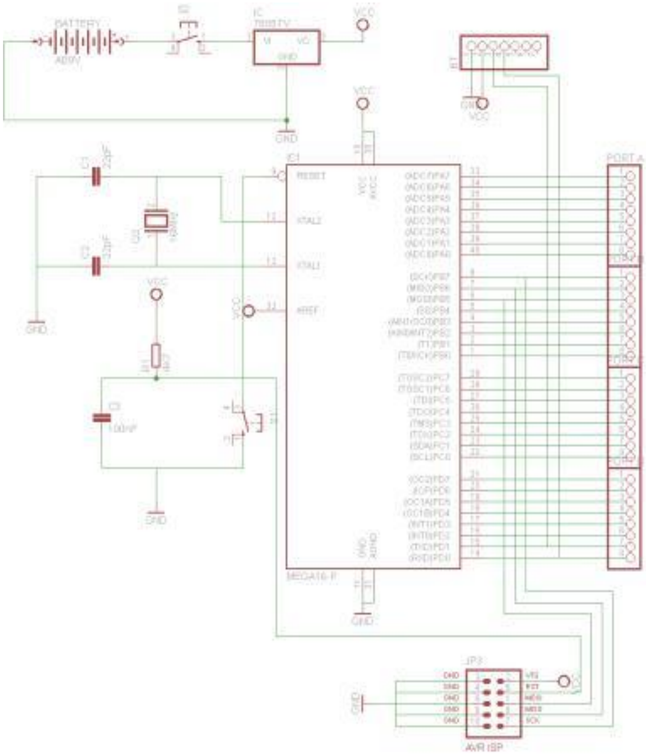

Fig 2. Schematic of hardware circuit diagrams

1. Design minimum system microcontroller AT Mega 16

The minimum system microcontroller ATmega16 is required in order to function properly. Therefore, the minimum system design is applied and become the primary circuit on additional hardware. A 16MHz crystal oscillator, two 22pF capacitors, a capacitor 10nF, a 4.7 KΩ resistor, and a push-button arranged in such a manner as shown in Figure 3.2. Pin VCC, AVCC and AREF is connected to the source voltage to the microcontroller is active as well as ADC features. ADC feature is enabled because it will be used by the microcontroller to process the analog data received from the sensors. GND and AGND pin is connected to ground.

2. The design of the infrared sensor

Infrared sensor consists of an IR LED and photodiode are arranged side by side. Infrared LED circuit is quite simple, by connecting the anode to the cathode to VCC and ground. For 330Ω resistor is included in it to prevent the receipt of a current too large by LEDs. Another thing with photodiode circuit is a little more complicated. Walking photodiode cathode connected to VCC and feet anode with ground (photodiode reverse bias assembled using the relationship). Besides connected to VCC, foot cathode is also connected to the 40th pin (Pin A0) AT Mega microcontroller 16. This pin serves as the microcontroller ADC channel used to receive data from the sensors. In the circuit there is also a 10 KΩ resistor provides the same functions as the resistor in the circuit of the IR LEDs. The series of infrared sensors on the detection system of human heart rate can be seen in Figure 3.

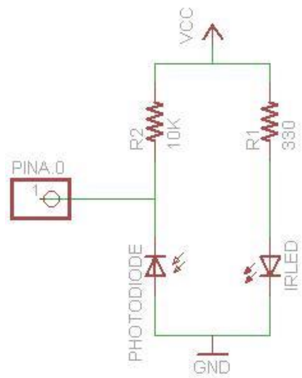

Fig 3. Infra-Red Sensor Circuit

3. The design of the Bluetooth module

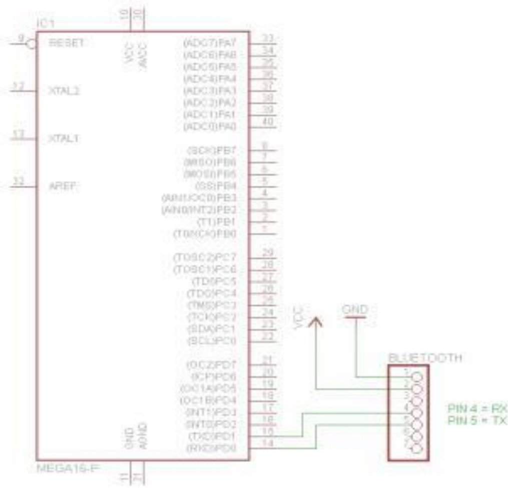

Fig 4. Bluetooth Module Circuit

Communication between hardware with mobile applications is done wirelessly (wireless) using Bluetooth technology. Bluetooth module used in this system is the type DFRobot V3. There are 7 feet owned by the Bluetooth module. However, only 4 feet used by the system. The legs are VCC, GND, TX and RX. Walking VCC and GND connected to the voltage source to activate the Bluetooth module. While Walking TX connected to pin 14 (RXD) and RX leg connected to the pin 15 (TXD) microcontroller. Both pin is responsible for delivering the data to be sent or received by the microcontroller via Bluetooth module. Bluetooth module circuit is shown in Figure 4.

B. *Flowchart*

Flow hardware program begins with the initialization Analog-to-Digital Converter (ADC). Initialization is intended to enable ADC features provided by CodeVision AVR. In addition to ADC, other features were used that USART. Therefore, the initialization process is also made to the USART. In this stage, both USART transmitter and receiver are enabled. Because the hardware is sending and receiving data from the application. The next stage is to initialize the port A as an input. Port A is set as an input for a sensor mounted on the port A. The sensors will provide data input to the microcontroller. A port initialization as the input is done via the command DDRA = 0x00. Port rest act as output because they will provide the data output of the microcontroller. For example, data to be sent by the Bluetooth module. The command to initialize the port as output is DDRi = 0xFF (i = Name of the port).

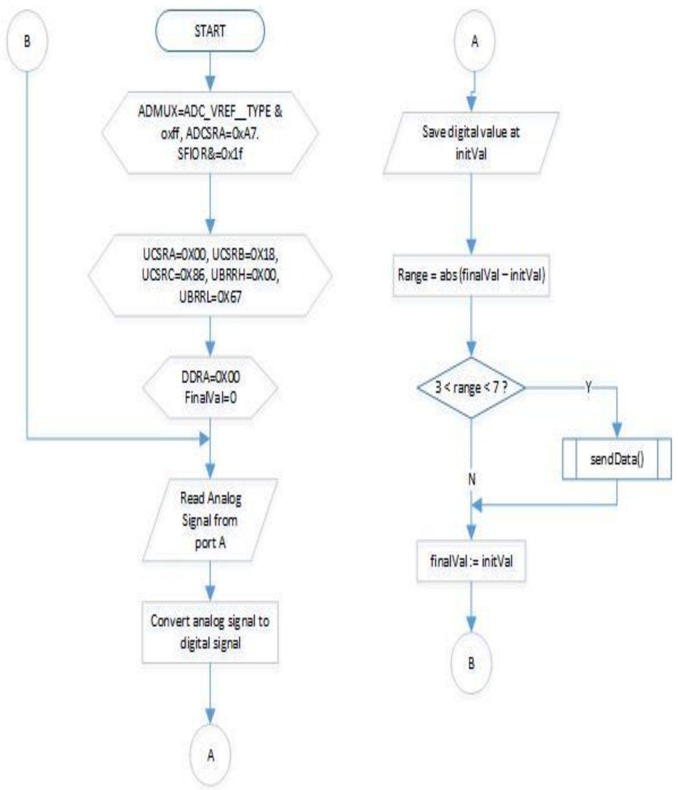

Fig 5. System Flowchart

There are several variables that were made in the program's hardware. Variables with names initVal, finalVal, and range, has an integer data type (int). While other variables with names transmitChar have a character data type (char). These variables will be used to store a certain value. FinalVal variable has an initial value of 0 (zero), while the other variables are set to have an initial value. Then, the program flow followed by reading from the sensor port A pin-0. The data obtained from the sensor is analog data, so it needs to be converted by the ADC into digital data that can be processed. Then, save the digital value in the variable initVal. A formula is used to process the finalVal and initVal value, the formula is:

$$range = [finalVal - initVal] \quad (1)$$

This Formula has a function of the difference between the absolute value finalVal initVal. The result of the calculation was then set as the variable value range. If the value range ranged between 3-7 then invoke subroutines SendData. If the requirements are not met, then proceed to the next command line. Commands from the sensor readings to call subroutines are in the loop forever. Accordingly, all such orders will continue to be repeated. Description of program flow is summarized in the flow diagram in Figure 5.

C. *Mobile Application Design*

Software design detection system human heart rate based on operating system Windows Phone 8.0 using the infrared sensor is divided into two parts. The first part is a program to run additional hardware. The second part is a mobile application that operates on a Windows phone. The program planted on a microcontroller fabricated using C language programming software used is CodeVision AVR. Another thing with mobile applications built using XAML and C #. XAML language is used to declare an application's user interface. Meanwhile, C # is used as the code-behind. Programming software is used to build their mobile applications is visual studio express for windows phone.

The program on the microcontroller intended for reading by the sensor and sending data via bluetooth. Mobile application consists of 2 pages which display the input (input) of user data and page output (output). Weather data entry page called "MainPage.xaml". This page is tasked to retrieve the data for age, sex, and activity. Although, there are two columns ie first name and last name are aiming for further development towards a database. The output page called "HeartbeatPivot.xaml" which allows you to display data from the application process. Data shown are gender, age, activity, heart rate, maximum heart rate (maximum heart rate), and its conclusions heartbeat condition. There is a timer (timer) which indirectly instruct users to keep putting the finger on the sensor during run time. This application has several methods that are declared and called on both pages. In the manufacturing process, these applications directly simulated in the windows phone operating system Windows Phone 8.0.

D. *Mainpage Interface*

Mainpage page has textblock 3 pieces, 4 pieces Radiobutton, an application bar button, and some TextBlock as shown in Figure 9. Elements of this interface serves as a user enters data. Column first name and last name will not affect the processing of the data by the application. The second column is intended for further development of the application Heartbeat.

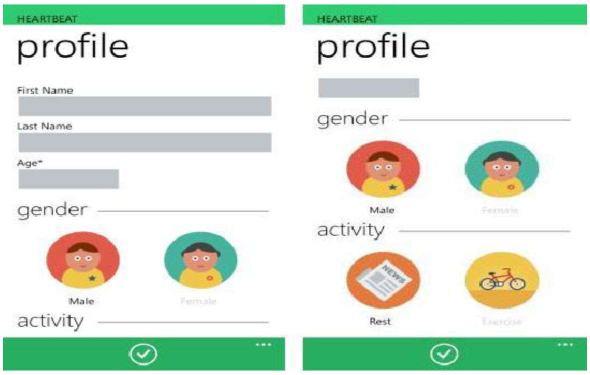

Fig 6. Main page Interface

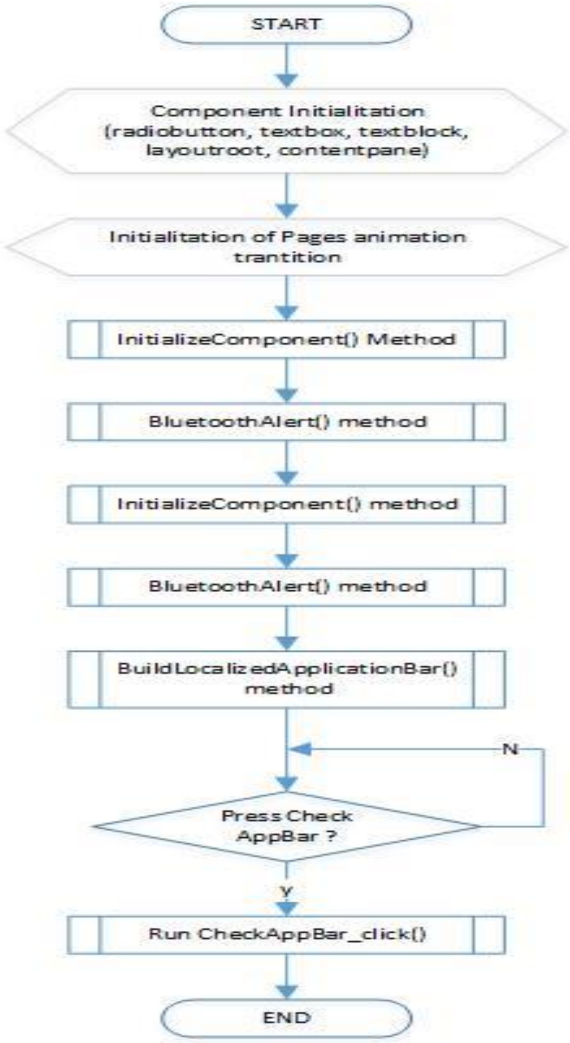

Fig 7. Main page Flowchart

Users must enter data for age, sex, and activity that is being conducted via this page. For the age data, user input by touching the age column. Then the on-screen keyboard will appear and the user can type a number of age. As for the data gender and activity, users simply touch one choice of several options available. Male gender selection is symbolized by the image of a male and female sexes is symbolized by the image of a woman. In the activity, choice of activity breaks symbolized by the image of newspapers and strenuous activity symbolized by pictures bike.

E. *Heart rate Detection System*

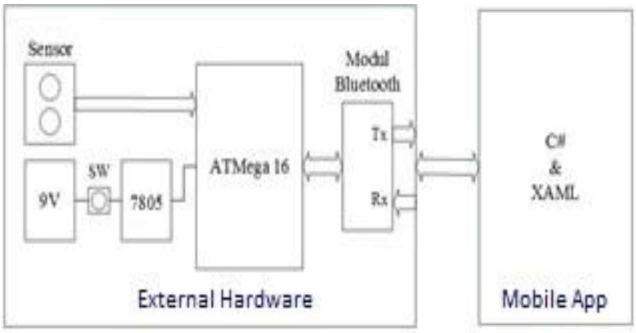

Fig 8. Heart rate Detection System

A schematic diagram of the entire system is shown in Figure 13. The system is divided into two parts, namely hardware and mobile applications. The hardware includes a microcontroller, sensors, power supply, Bluetooth modules, and other electronic components are incorporated in an electrical circuit. The hardware will transmit heart rate data on the application to be processed. The mobile application will calculate the number of beeps and concluded normality of the heart rate of the user.

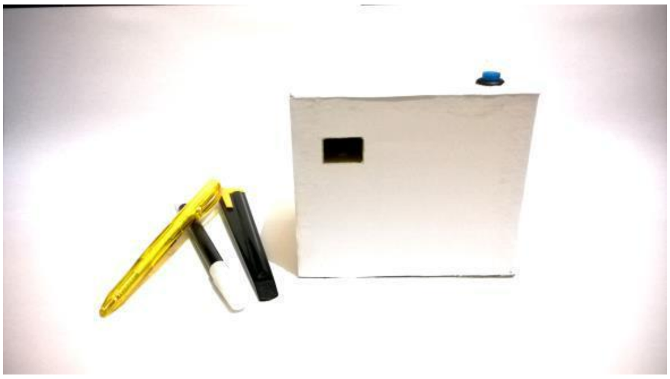

Fig 9. External Hardware

The device is composed of a variety of electronic components and integrated circuits incorporated in a PCB (Printed Circuit Board). PCB is packaged in a beam dimensions of 11.6 cm × 9 cm × 10 cm. The beam has two compartments: the battery space and PCB space. Hardware is powered by a 9V battery that is located on the bottom of the beam. A power button (power button) located on the upper side, while the sensor is in the front left side. Sensors placed in a cavity to minimize interference due to ambient light system. Looks beyond the hardware shown in Figure 8.

Users should turn on additional hardware by pressing the blue button before the application is run. Then to start the recording process, place your index finger on the sensor. Then, Bluetooth will send data to the application to be processed. All activities are governed by the microcontroller ATMega 16 embedded in the PCB measuring 12.5 cm × 7.5 cm. Physical appearance PCB is shown in Figure 15. The sensor has its own PCB (separate from the main PCB). This is because the sensor must be conditioned clamp user's finger. Thus, created two others on the system PCB is PCB IR LED and photodiode. PCB IR LEDs are placed at the bottom of the cavity (LED attached to the fingers) and photodiode PCB. There is on the finger (photodiode attached to the nail).

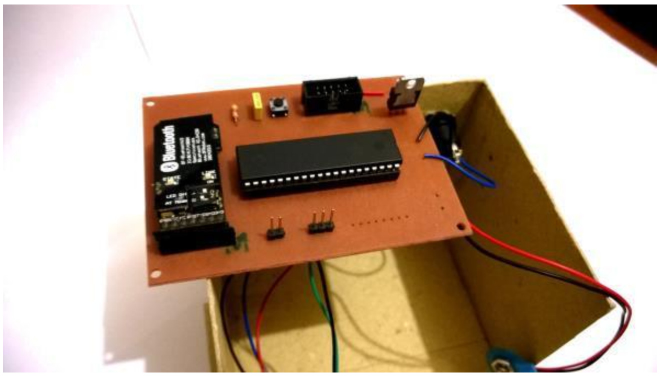

Fig 10. Main PCB

III. TESTING

Table I. Users identity

Input Data			Output Data						
Age	Sex	Activity	HR	Max HR	Age	Sex	Activity	Status Bar	Animation
20	Man	Rest	×	200	20	Male	Rest	Device is ready	×
35	Man	Exercise	×	200	35	Male	Exercise	Device is ready	×
20	Woman	Rest	×	189	20	Female	Rest	Device is ready	×
35	Woman	Exercise	×	189	35	Female	Exercise	Device is ready	×

*HR = Heart Rate

Table II. Users tests

Input Data			Output Data						
Age	Sex	Activity	HR	Max HR	Age	Sex	Activity	Status Bar	Animation
20	Man	Rest	×	200	20	Male	Rest	Recording Your Heartbeat	MyAnimatedEllipse, MyAnimatedLittleEllipse, txbRateOut
35	Man	Exercise	×	200	35	Male	Exercise	Recording Your Heartbeat	MyAnimatedEllipse, MyAnimatedLittleEllipse, txbRateOut
20	Woman	Rest	×	189	20	Female	Rest	Recording Your Heartbeat	MyAnimatedEllipse, MyAnimatedLittleEllipse, txbRateOut
35	Woman	Exercise	×	189	35	Female	Exercise	Recording Your Heartbeat	MyAnimatedEllipse, MyAnimatedLittleEllipse, txbRateOut

Table III. Calibration Test

Testing	Real Heart rate	App Heart rate	Different	Real Status	App Status	Conclusion	
						HR	Result
1	80	72	-8	Normal	Normal	False	True
2	72	69	-3	Normal	Normal	False	True
3	72	61	-11	Normal	Normal	False	True
4	76	80	+4	Normal	Normal	False	True
5	72	87	+15	Normal	Normal	False	True
6	80	94	+14	Normal	Normal	False	True
7	72	87	+15	Normal	Normal	False	True
8	76	65	-11	Normal	Normal	False	True
9	76	47	-29	Normal	Low	False	False
10	76	69	-7	Normal	Normal	False	True
11	72	83	+11	Normal	Normal	False	True
12	76	120	+44	Normal	High	False	False
13	84	98	+14	Normal	Normal	False	True
14	76	98	+22	Normal	Normal	False	True
15	76	87	+11	Normal	Normal	False	True
16	72	61	-11	Normal	Normal	False	True
17	72	91	+19	Normal	Normal	False	True
18	84	120	+36	Normal	High	False	False
19	76	50	-26	Normal	Low	False	False
20	72	72	0	Normal	Normal	True	True
21	76	69	-7	Normal	Normal	False	True
22	76	58	-18	Normal	Normal	False	True
23	76	65	-11	Normal	Normal	False	True
24	72	61	-11	Normal	Normal	False	True
25	72	65	-7	Normal	Normal	False	True
26	84	83	-1	Normal	Normal	False	True
27	72	80	-8	Normal	Normal	False	True
28	72	69	-3	Normal	Normal	False	True
29	72	72	0	Normal	Normal	True	True
30	76	83	7	Normal	Normal	False	True

Testing condition:

1. The value of the calibration used is 0.91. This value is used to minimize the difference between pulse applications with normal pulse.

2. Percentage Error:

   $\sum$different = 384

   $$\text{Different Average} = \frac{\sum \text{different}}{30} = 12.8$$

   $$\text{Error} = \frac{4}{30} \times 100\% = 13.33\ \%$$

3. Pulse and decisions fact is measured by calculating the heart rate manually by pressing a finger on the body that feels the pulse.

IV. CONCLUSION

1. Application detection of human heart rate based on operating system Windows Phone 8.0 using the infrared sensor successfully realized. Applications built using the language XAML and C # with Visual Studio Express for Windows Phone.

2. Additional hardware successfully realized in the form of Printed Circuit Board (PCB) and packaged in blocks. The hardware is programmed using C language to program

AVR CodeVision. No problems were found that the percentage of errors on certain aspects. The error is most likely caused by a mismatch of sensors. However, this can be minimized by providing calibration value.

3. Additional hardware with mobile applications can be connected with a Bluetooth connection. The hardware is able to send data, and the application is able to receive data from the hardware properly.

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